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## Ebola US Patient Zero: lessons on misdiagnosis and effective use of electronic health records

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### Abstract

On September 30th, 2014, the Centers for Disease Control and Prevention (CDC) confirmed the first travel-associated case of US Ebola in Dallas, TX. This case exposed two of the greatest concerns in patient safety in the US outpatient health care system: misdiagnosis and ineffective use of electronic health records (EHRs). The case received widespread media attention highlighting failures in disaster management, infectious disease control, national security, and emergency department (ED) care. In addition, an error in making a correct and timely Ebola diagnosis on initial ED presentation brought diagnostic decision-making vulnerabilities in the EHR era into the public eye. In this paper, we use this defining “teachable moment” to highlight the public health challenge of diagnostic errors and discuss the effective use of EHRs in the diagnostic process. We analyze the case to discuss several missed opportunities and outline key challenges and opportunities facing diagnostic decision-making in EHR-enabled health care. It is important to recognize the reality that EHRs suffer from major usability and inter-operability issues, but also to acknowledge that they are only tools and not a replacement for basic history-taking, examination skills, and critical thinking. While physicians and health care organizations

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ultimately need to own the responsibility for addressing diagnostic errors, several national-level initiatives can help, including working with software developers to improve EHR usability. Multifaceted approaches that account for both technical and non-technical factors will be needed. Ebola US Patient Zero reminds us that in certain cases, a single misdiagnosis can have widespread and costly implications for public health.

## Keywords

cognition; decision-making; diagnostic error; Ebola; electronic medical records; health information technology; human factors; misdiagnosis; patient safety

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## Introduction

On September 30th, 2014, the Centers for Disease Control and Prevention (CDC) confirmed the first travel-associated case of US Ebola in Dallas, TX, which eventually led to the death of the patient on October 8th. On October 15th, in his testimony to the US Congress, the Chief Clinical Officer of Texas Health Resources said “Unfortunately, in our initial treatment of [Patient Zero]... we made mistakes. We did not correctly diagnose his symptoms as those of Ebola. We are deeply sorry” [1]. The mishandling of US Patient Zero is receiving widespread media attention highlighting failures in disaster management, infectious disease control, national security, and emergency department (ED) care. In addition, an error in making a correct and timely Ebola diagnosis on initial ED presentation also brought decision-making vulnerabilities in the era of the Electronic Health Record (EHR) into the public eye. The misdiagnosis and subsequent treatment of US Patient Zero has generated fear, uncertainty, and doubt about the competence of our health care delivery system. While there are many lessons to be learned, we use this defining “teachable moment” to highlight the public health challenge of diagnostic errors and the effective use of EHRs in the diagnostic process. Analysis of this case reveals several missed opportunities and key issues that warrant attention from the medical and policy communities.

## Case history

Although discrepancies exist in information about the chain of events that transpired when Patient Zero presented to the ED, we have used the hospital’s testimony and additional publically available information, including preliminary findings released to the public from the 1400 pages of medical records made available to the Associated Press (AP) by the patient’s family, to reconstruct the chain of events [2]. According to the Texas Health Presbyterian Hospital in Dallas, TX, on September 25th, US Patient Zero (Mr. Thomas Eric Duncan) presented with a temperature of 100.1F, dizziness, nausea, abdominal pain, a sharp headache, and decreased urination [3]. Both the testimony and AP records reveal that 3.5 h into the patient’s visit to the ED his temperature spiked to 103 degrees, which later dropped to 101.2 degrees [4]. The patient rated his “severe pain” at eight on a scale of one to ten, which contradicts the initial hospital statement that the patient’s symptoms “were not severe at the time he first visited the hospital emergency department.” His travel history from Liberia, a country highlighted in recent news, was recorded in the nurse’s notes. Based on the publically available information and the testimony, it is clear that this information was

not appreciated or acted upon. He was prescribed antibiotics, told to take Tylenol, and discharged after 4 h in the ED. The AP records also indicate the diagnosis given to US Patient Zero before his discharge “included sinusitis” but that CT scans of “head and abdomen” ordered during the ED visit showed no evidence of sinusitis or other conditions such as stroke or appendicitis [5]. Two days later, the patient worsened and returned to the same ED and was subsequently admitted to the hospital.

On October 1st, the hospital announced that the initial ED nurse failed to communicate the travel history to physicians. The next day they blamed a technical flaw in the EHR – the misalignment of the physicians’ and nurses’ workflows – which prevented physicians from seeing the travel history in the nurse’s notes. Within 24 h they reversed their position and announced that the travel history was indeed documented and available to the full care team in the EHR within the physician’s workflow, and there was no flaw in the EHR [3].

The initial ED progress notes were not available for us to review. However, based on our experience in analyzing these issues, we hypothesize the following explanations about the EHR-related documentation at the first visit to explain some of the discrepancies. According to AP, the ED physician’s note said Mr. Duncan was “negative for fever and chills”; however, this could have been selected erroneously from a series of pre-defined symptom options in the EHR system. Further on, the note reads: “I have given patient instructions regarding their diagnosis, expectations for the next couple of days, and specific return precautions. The condition of the patient at this time is stable.” Because of the generic nature of this phrase and the use of a gender-neutral plural pronoun when referring to a patient, we believe this phrase was likely selected from a set of pre-defined patient instructions and may not have accurately reflected the physician’s true intent.

## The complexity of diagnostic errors and the role of the EHR

Contradictory statements from the hospital and the lack of full transparency have complicated the factual analysis of this case, a critical and urgent public health emergency. Nevertheless, the misdiagnosis of US Patient Zero is a perfect prototype for one of the biggest vulnerabilities of outpatient medicine. The incidence of diagnostic error is thought to be in the range of 10%– 15% [6]; in the US alone, approximately 12 million adults are estimated to be misdiagnosed annually in outpatient settings [7]. Diagnostic errors are not new and are seen in both rare conditions, and common ones, such as cancers, cardiovascular conditions, and other infections. Both systems and cognitive factors are usually at play in these cases [8], and many breakdowns involve missing obvious clues when obtaining the patient’s history and performing the physical exam [9–11]. Perhaps the biggest red flag in this case was the patient himself, a black man with a foreign accent who reported he came from Liberia and presented with serious “flu-like” symptoms to an ED which reportedly had received CDC and county health department’s guidance as early as July 28th, 2014 [1]. We do not know whether the significance of this red flag was fully comprehended by either the registration clerk who would have checked the patient’s identification or the nurse who documented his travel. It is also unknown if the large presence of immigrants in the area led to complacency on the part of providers to overlook travel history. The Dallas County Commissioner referred to the hospital as being located “next to a little Ellis Island” hinting

at the large immigrant population in the area. What is clear is that the importance of the geographic link to Liberia/West Africa was not appreciated by the treating physician. According to the World Health Organization (WHO), most confirmed, probable, or suspected Ebola deaths have occurred in three West African countries: Liberia, Sierra Leone, and Guinea. Thus, the available evidence suggests that the physician did not obtain or appreciate the travel history during the patient encounter and did not consider the possibility of Ebola infection.

Assigning blame to the EHR is not new and often reflects a reluctance to address the complex cognitive and/or performance issues involving front-line staff, especially those related to responsibility and accountability. It is important that we recognize the reality that EHRs suffer from major usability and inter-operability issues [12–14], but also to acknowledge that they are only tools and not a replacement for basic history-taking, examination skills, and critical thinking [15]. Let us not forget that the diagnosis of Ebola in West Africa is not aided by EHRs. Basic clinical skills will be more important than ever because research reveals that clinicians often miss relatively common conditions [10].

Several other ‘human factor’ issues may have contributed to the diagnostic error in this case. A host of system-related factors detract from optimal conditions for critical thinking in the ED, leading clinicians to lose situational awareness [16]. These include production pressures, distractions, and inefficient processes. Also, physicians tend to ignore nursing notes, whether on paper or in the EHR. Many organizations modify their EHR-related workflows to ensure that specific data elements required for quality measures (none of which focus on diagnostic quality) are reliably captured. In the Ebola case, the nurse was using a template “designed to provide a high reliability nursing process to allow for the administration of influenza vaccine under a physician-delegated standing order” to record history [3]. These highly-constrained tools are optimized for data capture but at the expense of sacrificing their utility for appropriate triage and diagnosis, leading users to miss the forest for the trees.

The implications of the misdiagnosis were profound. Emerging details reveal that even after the second ED visit which led to hospitalization, strict Ebola isolation precautions were not followed for 2 days, until the diagnosis was confirmed by the CDC. While there was clinical suspicion of a life-threatening diagnosis on this admission, it is uncertain if this was overshadowed due to possible over-reliance on diagnostic testing to confirm the diagnosis.

## Policy and practice reform to address diagnostic error in the EHR-era

Physicians and health care organizations ultimately need to own the responsibility for addressing diagnostic errors, but several national-level initiatives can help, including working with software developers to improve EHR usability. Despite their emerging significance, diagnostic errors are largely ignored by policy-makers, industry, and health care institutions in part due to their complexity and measurement challenges [17–19]. Within the many initiatives attempting to improve patient safety and value-based purchasing being promoted by Congress, the Centers for Medicare and Medicaid Services (CMS), large health care purchasers, and health plans, virtually none relate to accuracy and timeliness of

diagnosis [20]. Outpatient reimbursement policies do not reward diagnostic decision-making, teamwork, or quality time spent with the patient in making a diagnosis.

Many of these policy and practice issues are especially relevant for primary care and emergency rooms, which are often considered “laboratories” for diagnostic errors. Rigorous teamwork-related practices are needed to help transform these busy outpatient settings where communication and coordination breakdowns are prevalent [21]. High-risk clinical processes need to become much more reliable so that vital opportunities and clues are not missed. As this case illustrates, EHR-based clinical workflows often fail to optimize information sharing amongst various team members, leading to lapses in recognizing specific clinical findings that could aid in rapid and accurate diagnosis. In addition, physicians need timely feedback on diagnostic accuracy if they are to learn from their actions, but such systems do not exist [22] nor are there any incentives to build them. Clinical practice must have systems of feedback loops about patient outcomes so we can learn from mistakes [23, 24]. Widespread use of EHRs and better data availability should facilitate the development of these systems [25].

Multifaceted approaches that account for both technical and non-technical factors will be needed to prevent misdiagnosis in the EHR-era [26]. Current EHRs lack the innovations needed to prevent misdiagnosis. Condition-specific charting templates, drop-down selection lists, and checkboxes developed in response to billing or quality reporting requirements potentially distort history-taking, examination, and their accurate and comprehensive recording. We suspect this might have occurred in this case. Clinicians also tend to ignore template-generated notes in their review process; often the signal-to-noise ratio in these notes is low. EHRs can lead to less verbal exchange [27], which is all the more needed and more effective when dealing with complex tasks and communicating critical information [28]. Ideally, the nurse should have verbally communicated the red flag to the physician instead of relying on the physician to find this information in the EHR. Other factors, such as heavy data entry requirements and frequent copy-and-paste from previous notes, detract from critical thinking during the diagnostic decision-making process [29]. Improving diagnosis and reducing diagnostic errors in the EHR-era should thus be a major research priority. For EHRs to be most effective, they need to be able to automatically sort through patient data, identify the pertinent findings, and present them in an easy to understand manner. Computer algorithms could combine patient-specific information with the latest evidence-based clinical knowledge to help clinicians reach the correct diagnosis.

This first case of Ebola in the US has exposed two of the greatest concerns in patient safety in the US outpatient health care system: misdiagnosis and ineffective use of EHRs. This only increases the significance and responsibility of the consensus study on diagnostic errors commissioned by the Institute of Medicine, and expected to be released in Fall 2015. Diagnostic errors typically have affected only one patient at a time [10], but Patient Zero reminds us that in certain cases, a single misdiagnosis can have widespread and costly implications for public health.

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